US009091109B2

(12) **United States Patent**
Busch et al.

(10) **Patent No.: US 9,091,109 B2**
(45) **Date of Patent: Jul. 28, 2015**

(54) **REVOLVING DOOR WITH A DRIVE UNIT ARRANGED AT A GLASS CEILING ELEMENT**

(71) Applicants: **Sven Busch**, Dortmund (DE); **Stefan Kissler**, Leverkusen (DE); **Thomas Schmitz**, Wesseling (DE)

(72) Inventors: **Sven Busch**, Dortmund (DE); **Stefan Kissler**, Leverkusen (DE); **Thomas Schmitz**, Wesseling (DE)

(73) Assignee: **Dorma Deutschland GmbH**, Ennepetal (DE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 5 days.

(21) Appl. No.: **14/154,433**

(22) Filed: **Jan. 14, 2014**

(65) **Prior Publication Data**

US 2014/0196374 A1 Jul. 17, 2014

(30) **Foreign Application Priority Data**

Jan. 14, 2013 (DE) 10 2013 000 423

(51) **Int. Cl.**

E05F 15/10	(2006.01)
E06B 11/08	(2006.01)
E05F 15/60	(2015.01)
E05F 15/608	(2015.01)

(52) **U.S. Cl.**

CPC ***E05F 15/106*** (2013.01); ***E05F 15/60*** (2015.01); ***E05F 15/608*** (2015.01); ***E06B 11/08*** (2013.01); *E05Y 2201/438* (2013.01); *E05Y 2201/442* (2013.01); *E05Y 2201/446* (2013.01); *E05Y 2600/45* (2013.01); *E05Y 2900/132* (2013.01)

(58) **Field of Classification Search**

CPC E05F 15/106; E05F 15/60; E05F 15/608; E06B 11/08; E05Y 2900/132; E05Y 2201/442; E05Y 2201/438; E05Y 2600/45; E05Y 2201/446

USPC 49/42–47

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,007,213	A	*	7/1935	Peremi et al.	49/45
2,050,584	A	*	8/1936	Peremi et al.	49/43
2,136,323	A	*	11/1938	Shields	362/147
2,186,385	A	*	1/1940	Lockart	292/33
2,341,545	A	*	2/1944	Hagenbook	49/42
2,523,980	A	*	9/1950	Whiteford	49/44
3,349,876	A	*	10/1967	Sheckells	188/185
3,364,620	A	*	1/1968	Hess et al.	49/43
3,736,701	A	*	6/1973	Rush et al.	49/44
3,766,686	A	*	10/1973	Sheckells	49/43
3,897,651	A	*	8/1975	Sheckells	49/43
4,332,108	A	*	6/1982	Appelmann	49/44
4,341,165	A	*	7/1982	Calandritti et al.	109/8
4,358,909	A	*	11/1982	Trikilis	49/42
4,458,447	A	*	7/1984	Heise et al.	49/44
4,557,073	A	*	12/1985	Sandling	49/41
4,627,193	A	*	12/1986	Schwarz	49/42

(Continued)

FOREIGN PATENT DOCUMENTS

DE	197 11 460	11/1997
EP	2 072 737	6/2009

Primary Examiner — Katherine Mitchell

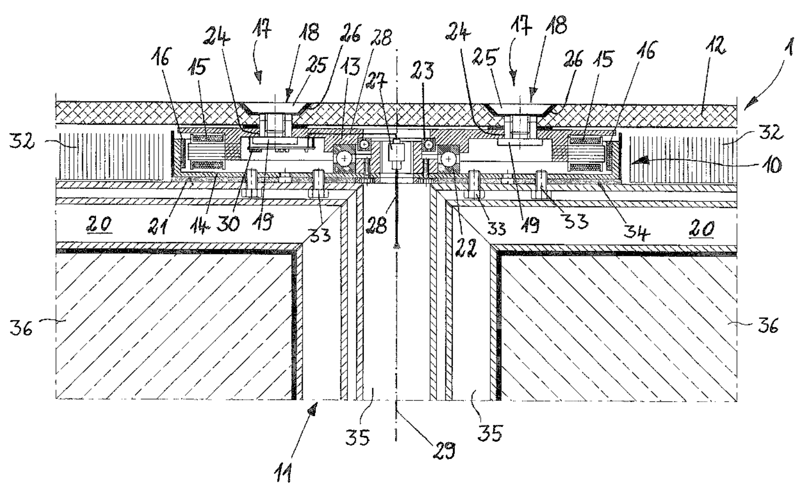
Assistant Examiner — Justin Rephann

(74) *Attorney, Agent, or Firm* — Cozen O'Connor

(57) **ABSTRACT**

A revolving door with a drive unit drivingly connected to a turnstile of the revolving door. The revolving door has at least one glass ceiling element. The drive unit is gearlessly constructed and has an electronically commutated multipole motor. The multipole motor is arranged at the glass ceiling element.

13 Claims, 2 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,660,322	A *	4/1987	Lowe	49/44
4,763,053	A *	8/1988	Rabe	318/400.41
4,874,975	A *	10/1989	Hertrich	310/186
4,970,825	A *	11/1990	Knarvik	49/44
4,976,065	A *	12/1990	Beran et al.	49/43
5,634,295	A *	6/1997	Bunzl	49/45
5,773,943	A *	6/1998	Andersen	318/432
5,825,901	A *	10/1998	Hisey	381/165
6,266,922	B1 *	7/2001	Rockenbach	49/42
8,136,297	B2 *	3/2012	Bzorgi	49/43
2008/0028682	A1 *	2/2008	Casella et al.	49/25
2008/0047200	A1 *	2/2008	Krause et al.	49/31
2008/0244978	A1 *	10/2008	Soyugenc	49/42
2009/0188166	A1 *	7/2009	Taheri et al.	49/31
2009/0189560	A1 *	7/2009	Taheri et al.	318/445
2009/0206777	A1 *	8/2009	Taheri et al.	318/15
2012/0005961	A1 *	1/2012	Busch et al.	49/46

* cited by examiner

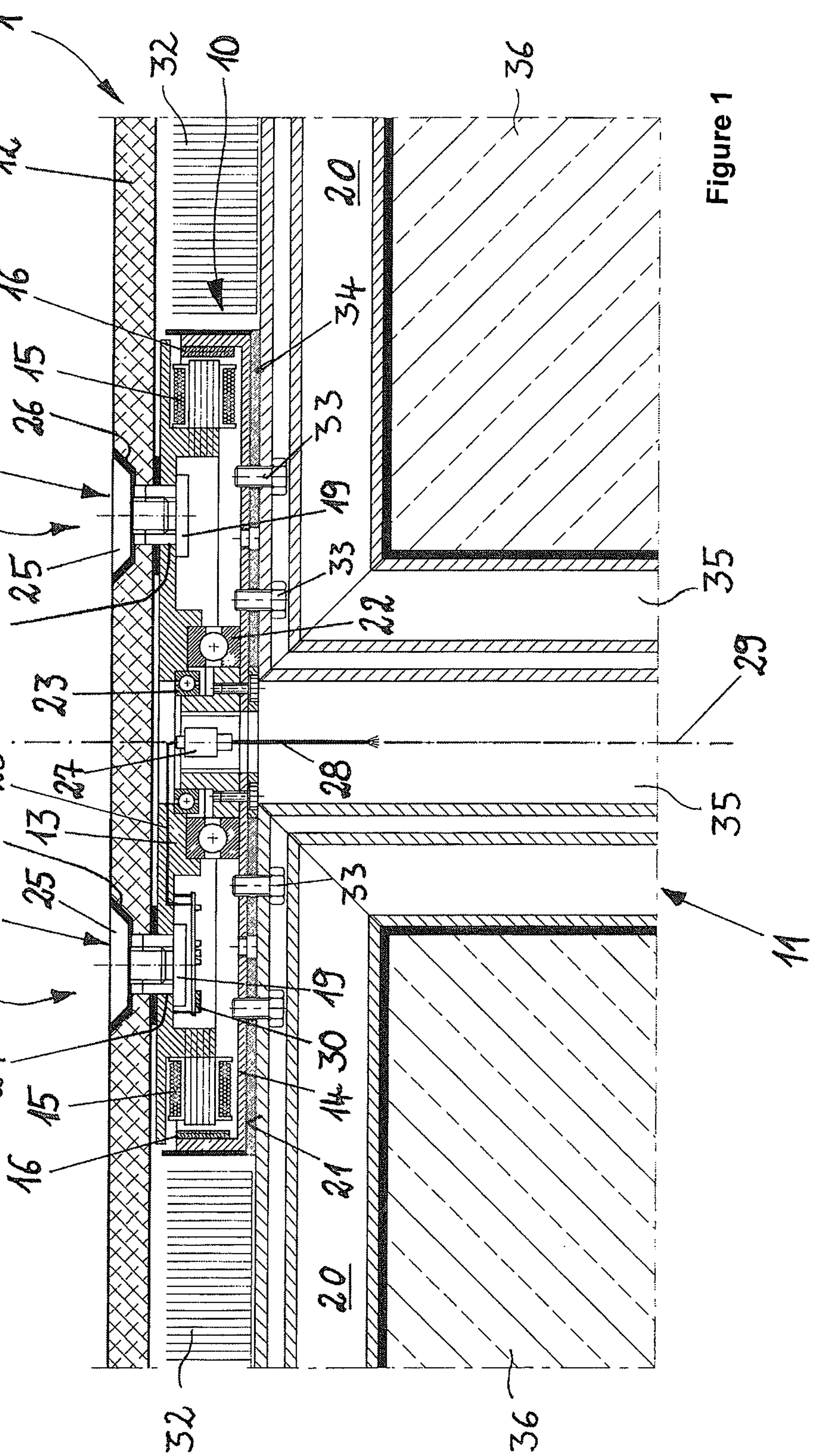

1
12
32
10
36
20
16
15
26
18
17
25
24
19
33
34
22
23
27
28
29
35
13
30
14
21
11

Figure 1

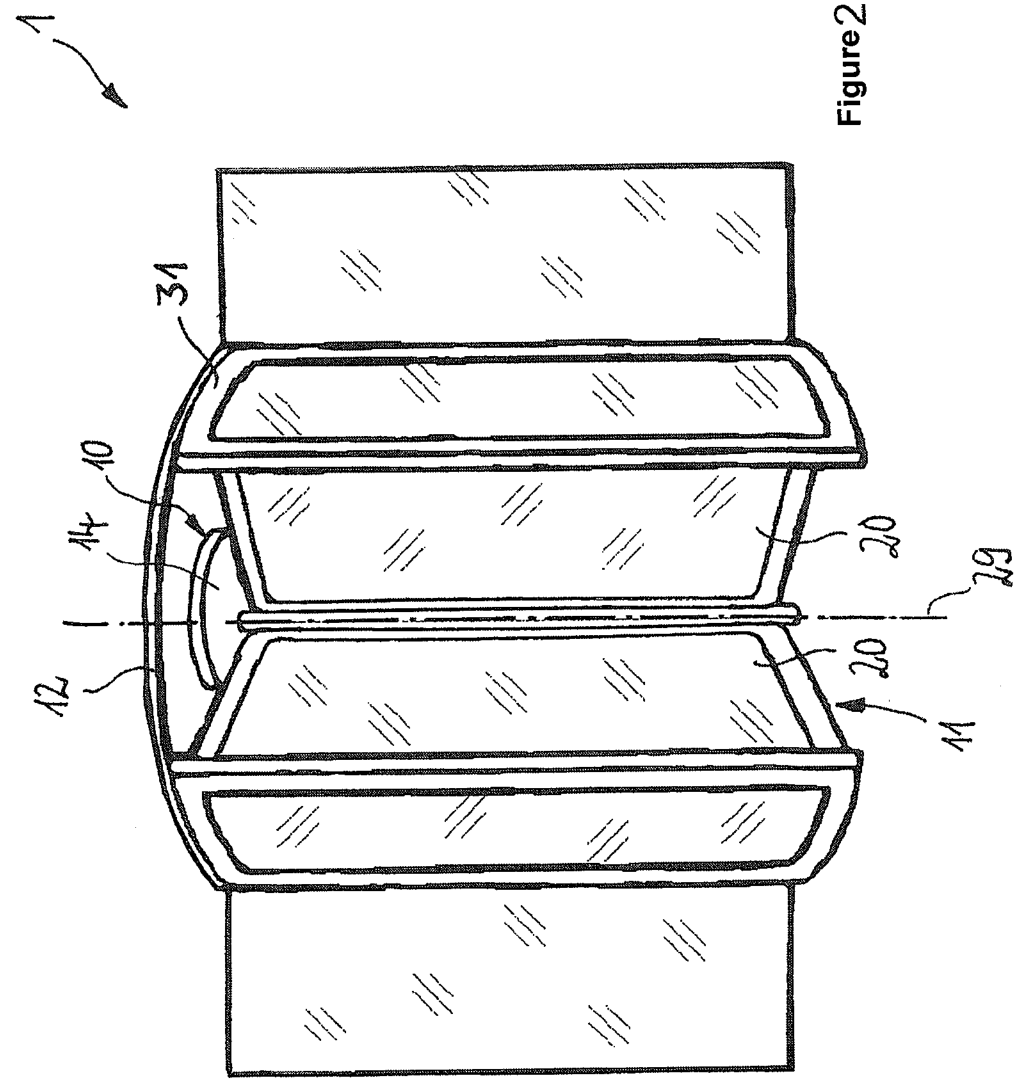


Figure 2

REVOLVING DOOR WITH A DRIVE UNIT ARRANGED AT A GLASS CEILING ELEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a revolving door with a drive unit drivingly connected to a turnstile of the revolving door, wherein the revolving door has at least one glass ceiling element.

2. Description of the Related Art

A generic revolving door with a drive unit which is drivingly connected to a turnstile of the revolving door is known from DE 197 11 460 A1. The drive unit is floor-mounted and drives the turnstile of the revolving door by a gearbox by a motor. The large structural dimensions of the motor and gearbox for driving the turnstile prohibit ceiling-side mounting because the revolving door has a glass ceiling element. The turnstile of the revolving door comprises a plurality of revolving wings that reach to the underside of the glass ceiling element, and the revolving wings are connected to one another in a common rotational axis by swing arms. The diagram shows the filigree construction of a glass ceiling element at which facade elements abut above the revolving door. An arrangement of the drive unit below or above the glass ceiling element for driving the turnstile of the revolving door would not be possible without a considerable expenditure.

EP 2 072 737 A2 shows a revolving door with a drive unit drivingly connected to a turnstile of the revolving door. The drive unit is ceiling-mounted. A revolving door construction of this kind illustrates the installation space required for integrating the drive unit above the turnstile. This type of arrangement of the drive unit combined with a filigree glass ceiling element of the revolving door cannot be reasonably implemented.

SUMMARY OF THE INVENTION

An object of one embodiment of the invention is a revolving door with a drive unit, wherein the revolving door has a glass ceiling element and has an improved arrangement and/or construction of a drive unit.

According to one embodiment, of the invention comprises a drive unit that is gearlessly constructed and has an electronically commutated multipole motor, wherein the multipole motor is arranged at the glass ceiling element.

The invention is based on the idea of taking advantage of the specific geometrical dimensions of a multipole motor by arranging the multipole motor at the glass ceiling element. Multipole motors are also known as torque motors and, due to their multipole construction, have a very high torque even at very low rotational speeds. Accordingly, the drive unit can be constructed gearlessly and the multipole motor can be directly connected to the turnstile without the intermediary of a gearbox. Therefore, the rotating part of the multipole motor has the same rotational speed as the turnstile of the revolving door and can have a drive axis coinciding with the rotational axis of the turnstile.

An advantage achieved by embodying the drive unit as an electronically commutated multipole motor is that the small structural dimensions of the multipole motor allow the drive unit to be arranged at the glass ceiling element without the drive unit having, for example, an excessive weight that cannot be supported by a glass ceiling element. A further advantage which is achieved consists in that a filigree-like glass ceiling element need not be structurally combined with a drive unit of large dimensions, which offers advantages particularly with respect to the construction of the building facade bordering the revolving door.

The revolving door has a frame and the canopy of the frame of the revolving door can be partially or entirely formed of glass. The glass ceiling element can form a part of the canopy or the entire canopy of the frame of the revolving door. The drive unit in the form of a multipole motor can also be arranged at more than one individual glass ceiling element. For example, the canopy of the revolving door can have round dimensions and be formed of a plurality of glass ceiling elements which are put together in halves or equally, for example, or the canopy of the frame can be formed of a plurality of glass ceiling elements in the shape of pie slices. In this respect, the invention provides the arrangement of the drive unit particularly in the center of the circularly shaped canopy of the revolving door made of glass. Accordingly, the glass canopy can be constructed either as a frameless all-glass canopy, as a framed glass canopy or as a part-glass canopy and can comprise one or more glass ceiling elements.

In a particularly advantageous manner, the multipole motor can be arranged at the underside of the glass ceiling element. This achieves the advantage that the drive unit is protected from environmental influences. Therefore, no sealing work is required because the multipole motor is already protected against moisture and other environmental influences by the at least one glass ceiling element. If the drive unit were mounted above the glass ceiling element or in the extension plane of the glass ceiling element, an additional sealing step would be needed to protect against climatic influences. A further advantage of the arrangement of the multipole motor at the underside of the glass ceiling element consists in that the overall construction of the revolving door can terminate on top with the at least one glass ceiling element. Accordingly, a further facade construction can adjoin the revolving door in a correspondingly simple manner and the revolving door can be integrated in a simple manner in the facade construction.

The multipole motor can have a substantially round, flat base structure, a disk-shaped or cup-shaped stator part and a disk-shaped or cup-shaped rotor part which is arranged in a plane parallel relative to the stator part. In particular, either the stator part or the rotor part can be disk-shaped or cup-shaped and when one of the two parts has a cup shape it can substantially enclose the disk shape of the other part. The coplanarity of the cup-shaped part relative to the disk-shaped part refers to a base area of the cup-shaped part which extends in a plane parallel to the disk shape of the other part.

In a further advantageous manner, the multipole motor can have a quantity of coil elements and a quantity of magnet elements, and the coil elements and the magnet elements are arranged in an area between the stator part and the rotor part. When at least one of the parts is cup-shaped and is enclosed by another part which is disk-shaped, this results in a compact construction of the multipole motor with magnets and coils integrated between the disk shape and the cup shape. Since the coil elements must be electrically contacted, it is advantageous that they are received in the stationary stator part. Conversely, the magnet elements can be arranged at the rotating rotor part.

Connections that connect the stator part of the multipole motor to the glass ceiling element can be provided for a further advantageous configuration of the revolving door. For example, the connections can be formed as point-mount glass fasteners that include in particular at least one screw element and a sleeve element. The sleeve element can be guided through an opening arranged in the stator part and the screw element can have a conical head which is inserted into a conical receptacle in the glass ceiling element. At the same time, the conical receptacle forms an opening and guide-through for the screw element. The conical receptacle in the glass ceiling element can also carry out a sealing function so that moisture and dirt on top of the glass ceiling element which may be exposed to weather is prevented from reaching the underside of the glass ceiling element.

The turnstile of the revolving door can have two or more revolving wings and the revolving wings can be connected directly to the rotor part of the multipole motor. For example, the revolving wings can be arranged at the planar outer side, i.e., flat against the planar base side of the cup-shaped rotor part. To this end, screw elements can be provided, for example, for screwing the revolving wings to the rotor part. In particular, the revolving wings can comprise frame profiles in which glass elements are framed, and the screw connection can be arranged between the frame profiles and the rotor part. In a particularly advantageous manner, the rotor part can have a cup shape with a disk-shaped base segment facing in direction of the revolving wings of the turnstile. In particularly, this results in an especially simple connection between the revolving wings and the rotor part of the multipole motor because no additional connection elements, for example, shafts of the like, need be used when the revolving wings are connected directly to the base segment of the cup-shaped rotor part.

According to one embodiment of a connection shape between the rotor part and the revolving wings, the rotor part can be cup-shaped and comprise a circumferential cup surface portion. In this case, the revolving wings can also be connected in an advantageous manner at the outer side to the cup surface portion of the cup-shaped rotor part, for example, by screw elements.

The flat, particularly disk-shaped construction of the multipole motor results in a very small ratio of height to diameter of the drive unit. For example, the ratio of height to diameter of the round, flat base structure of the electronically commutated multipole motor can be at least 1:3, preferably at least 1:4, particularly preferably at least 1:5, and most preferably 1:8 or more. The greater the ratio of height to diameter, the flatter the base structure of the multipole motor and the shorter the distance between the top of the revolving wings and the underside of the glass ceiling element. This distance may be bridged by brush elements, for example, which can be arranged at the top of the revolving wings and brush against the underside of the glass ceiling element.

"Disk-shaped" means a flat cylinder in which the diameter is many times greater than the height. For example, the multipole motor can have a diameter of approximately 500 mm and a height of only about 40 mm. Further, the characterizing feature of a disk shape also applies when a multipole motor with a primarily disk-shaped configuration is intentionally changed to another similar shape. For example, a flat, polygonal frustum can surround the round stator part or rotor part which are round per se or, for example, the stator part or the rotor part has a shape which is not round and which deviates from a dish shape, for example, a flat cube. A reshaping of this kind can be carried out by enclosing the rotor part or stator part with a correspondingly shaped housing or by reshaping the coil cores in a corresponding manner.

According to embodiment of the electronically commutated multipole motor, the rotor part can be bearing-mounted at the stator part so as to be rotatable around a drive axis. "Drive axis" means an imaginary axis of rotation of the rotor part. In particular, at least one bearing, particularly at least one axial bearing and/or at least one radial bearing can be arranged between the stator part and the rotor part. In a particularly advantageous manner, the axial bearing can have increased dimensions so that ceiling loads acting on the multipole motor from the glass ceiling element can be supported by the axial bearing. Consequently, these ceiling loads can be transferred via the axial bearing through the multipole motor into the turnstile and can be absorbed by a further bearing arrangement in the base area of the turnstile.

The multipole motor can have at least one rotary feedthrough by which electric elements arranged in a stationary manner in the multipole motor can be electrically connected by at least one electric lead. For example, sensors or emergency switches can be installed in the turnstile of the revolving door and electrically connected to the electric elements which are arranged in a stationary manner in the multipole motor. The electric elements can form a control unit, for example, which serves to control the multipole motor. Similarly, it is also conceivable to connect all of the electrical connections, also including the power supply and further external control lines and signal lines of the multipole motor, through the rotary feedthrough by the electric lead so that the multipole motor can be integrated in the glass ceiling element without additional, unsightly electric leads. All of the electrical connections are carried out, for example, via the rotary feedthrough and through a center column of the turnstile, and a further rotary feedthrough through which the electric lead can be guided in a stationary manner into a further, adjoining base portion can be installed in the base area of the turnstile.

Accordingly, the entire power supply and signal supply of the multipole motor can be implemented via the base area on which the revolving door is arranged in spite of a ceiling mounting.

The multipole motor can have a position encoder or angle encoder serving for commutation and for determining angular positions and the rotating speed of the turnstile.

Other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, further steps improving the invention are explained in more detail in connection with the description of a preferred embodiment example of the invention with reference to the drawings. The drawings show:

FIG. **1** is a cross-sectional view of a revolving door with a multipole motor in a ceiling-mounted position; and

FIG. **2** is a schematic perspective view of the revolving door with a glass ceiling element beneath which the multipole motor is arranged and installed in direct operative connection with the turnstile.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

FIG. **1** shows a cross-sectional view of a revolving door **1** with a drive unit which is drivingly connected to a turnstile **11** of the revolving door **1**. A section of the revolving door **1** is shown in the upper, ceiling-side area, wherein the ceiling is formed, by way of example, by an individual glass ceiling element **12**. The drive unit is formed by an electronically commutated multipole motor **10** which is arranged, according to the invention, at the glass ceiling element **12** between the glass ceiling element **12** and the turnstile **11**. Consequently, the multipole motor **10** is shown arranged below the glass ceiling element **12** by way of example. The electronically commutated multipole motor **10** will be described in more detail in the following.

The electronically commutated multipole motor **1** comprises a stator part **13** and a rotor part **14**. The stator part **13** is formed so as to be disk-shaped and round, for example, and the rotor part **14** is cup-shaped, for example, and is arranged at the underside of the stator part **13**. A plurality of coil elements **15** and magnet elements **16** are located between the stator part **13** and the rotor part **14** and are arranged on a circular path around the drive axis **29**. Only two coil elements **15** and two magnet elements **16** are shown in the cross-sectional view. The coil elements **15** are received at the stator part **13** and the magnet elements **16** are received at the rotor part **14**.

The multipole motor **10** has a flat, substantially disk-shaped configuration extending around the drive axis **29**. Consequently, a plurality of coil elements **15** are distributed around the drive axis **29**, and a plurality of magnet elements **16** which are similarly distributed around the drive axis **29** are located on the inner side in the cup-shaped rotor part **14**. Because of the external arrangement of the magnet elements **16** with respect to the coil elements **15**, the multipole motor **10** is formed as an outrunner or external rotor so that a particularly high torque can be achieved by the multipole motor **10**.

A control unit **30** provides for electronic commutation of the coil elements **15** to generate a magnetic field rotating around the drive axis **29**, this control unit **30** likewise being arranged in the installation space between the stator part **13** and the rotor part **14**.

The stator part **13** is connected to the glass ceiling element **12** by connection elements **17**. The connection elements **17** are formed, for example, as point-mount glass fasteners and include a screw element **18** and a sleeve element **19**. The screw element **18** has a conical head **25** which sealingly fits into a conical receptacle **26** arranged in the glass ceiling element **12**. The conical receptacle **26** is adjoined by an opening in the glass ceiling element **12** so that the screw element **18** can be inserted through the opening. An opening **24** in the stator part **13** faces the respective opening in the glass ceiling element **12**, the sleeve element **19** being guided through this opening **24** and the screw element **18** is screwed into the sleeve element **19**. Only two connection elements **17** are shown in the cross-sectional view. More than two connection elements **17** can be provided between the multipole motor **10** and the glass ceiling element **12** particularly so as to be distributed around the drive axis **29**.

The turnstile **11** is shown with two revolving wing **20**. Three, four or more revolving wings **20** can form the turnstile **11** of the revolving door **1**, for example. The embodiment example shows a direct connection of the revolving wings **20** to the rotor part **14** of the multipole motor **10** by screw elements **33**. The revolving wings **20** have profile frames **35** and glass elements **36**; screw elements **33** connect the profile frames **35** of the revolving wings **20** to the rotor part **14**. A bezel element **34** which covers the underside of the rotor part **14** is arranged, for example, between the revolving wings **20** and the rotor part **14**.

An electric lead **28** is provided for electrically connecting the control unit **30** arranged in a stationary manner in the stator part **13**. A rotary feedthrough **27** integrated in the multipole motor **10** is incorporated in the electric lead **28**. Accordingly, the electric lead **28** is divided into a stationary part of the lead **28**, between the rotary feedthrough **27** and the control unit **30** within the multipole motor **10** and a part of the electric lead **28** which is outside of the multipole motor **10** and which rotates along with the turnstile **11**.

The rotor part **14** is mounted at the stator part **13** so as to be rotatable around the drive axis **29** by an axial bearing **22** and a radial bearing **23**. The axial bearing **22** is shown with increased dimensions so that ceiling loads which can act on the glass ceiling element **12** from the outside can be supported via the axial bearing **22** through the multipole motor **10** into the turnstile **11**.

Brush elements **32**, which can brush along the underside of the glass ceiling element **12** when the turnstile **11** rotates around the drive axis **29**, are arranged at the revolving wings **20** to bridge the vertical gap between the top of the revolving wings **20** and the underside of the glass ceiling element **12** lateral to the multipole motor **10**.

FIG. **2** shows a schematic perspective view of the revolving door **1** with a frame **31** encircling the glass ceiling element **12** arranged on top. A multipole motor **10** arranged below the glass ceiling element **12** drives the turnstile **11** in rotation. A direct connection between the rotor part **14** of the multipole motor **10** and the revolving wings **20** of the turnstile **11** is provided for driving the turnstile **11**.

Thus, while there have shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the spirit of the invention. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

What is claimed:

1. A revolving door comprising:

a turnstile;

a gearless drive unit having an electronically commutated multipole motor drivingly connected to the turnstile; and at least one glass ceiling element, wherein the multipole motor is arranged at the glass ceiling element, and wherein connection elements are provided that directly connect a stator part of the multipole motor to the glass ceiling element.

2. The revolving door (**1**) according to claim **1**, wherein the multipole motor (**10**) is arranged at an underside of the glass ceiling element (**12**).

3. The revolving door (**1**) according to claim **1**, wherein the multipole motor (**10**) comprises:

a substantially round, flat base structure;

the stator part (**13**); and

a rotor part (**14**) arranged in a plane parallel to the stator part (**13**).

4. The revolving door (**1**) according to claim **3**, wherein the multipole motor (**10**) comprises:

a plurality of coil elements (**15**); and

a plurality of magnet elements (**16**), wherein the plurality of coil elements (**15**) and the plurality of magnet elements (**16**) are arranged in an area between the stator part (**13**) and the rotor part (**14**).

5. The revolving door (**1**) according to claim **3**, wherein the turnstile (**11**) has revolving wings (**20**) connected to the rotor part (**14**), and wherein the revolving wings (**20**) are arranged at an outer surface (**21**) of the rotor part (**14**).

6. The revolving door (**1**) according to claim **3**, wherein the rotor part (**14**) is received in a bearing-mounted manner at the stator part (**13**) to be rotatable around a drive axis (**29**).

7. The revolving door (**1**) according to claim **6**, wherein at least one bearing configured as one of at least one axial bearing (**22**) and/or at least one radial bearing (**23**) is arranged between the stator part (**13**) and the rotor part (**14**).

8. The revolving door (**1**) according to claim **1**, wherein the connection elements (**17**) are formed as point-mount glass fasteners.

9. The revolving door (**1**) according to claim **8**, wherein the point-mount glass fasteners are at least a screw element (**18**) and a sleeve element (**19**).

10. The revolving door (**1**) according to claim **9**, wherein the sleeve element (**19**) is guided through an opening (**24**) in the stator part (**13**), and the screw element (**18**) has a conical head (**25**) that is inserted into a conical receptacle (**26**) in the glass ceiling element (**12**).

11. The revolving door (**1**) according to claim **1**, wherein the electronically commutated multipole motor (**10**) further comprises a round, flat base structure, and

wherein a ratio of a height of the round, flat base structure of the electronically commutated multipole motor (**10**) to a diameter of the round, flat base structure of the electronically commutated multipole motor (**10**) is at least 1:3.

12. The revolving door (**1**) according to claim **10**, wherein the ratio of a height of the round, flat base structure of the electronically commutated multipole motor (**10**) to a diameter of the round, flat base structure of the electronically commutated multipole motor (**10**) is at least 1:8.

13. The revolving door (**1**) according to claim **1**, wherein the multipole motor (**10**) further comprises at least one rotary feedthrough (**27**) by which electric elements arranged in a stationary manner in the multipole motor (**10**) are electrically connected by at least one electric lead (**28**).

* * * * *